General

Guideline Title

ACR Appropriateness Criteria® recurrent symptoms following lower extremity angioplasty.

Bibliographic Source(s)

Schenker MP, Rybicki FJ, Dill KE, Desjardins B, Flamm SD, Francois CJ, Gerhard-Herman MD, Kalva SP, Mansour MA, Mohler ER III, Oliva IB, Weiss C, Expert Panel on Vascular Imaging. ACR Appropriateness CriteriaÂ® recurrent symptoms following lower extremity angioplasty. [online publication]. Reston (VA): American College of Radiology (ACR); 2012. 7 p. [70 references]

Guideline Status

This is the current release of the guideline.

This guideline updates a previous version: Rybicki FJ, Kumamaru KK, Yucel EK, Baum RA, Desjardins B, Flamm SD, Foley WD, Jaff MR, Koss SA, Mammen L, Mansour MA, Mohler ER III, Narra VR, Schenker MP, Expert Panel on Vascular Imaging. ACR Appropriateness Criteria® recurrent symptoms following lower extremity angioplasty. [online publication]. Reston (VA): American College of Radiology (ACR); 2009. 6 p.

Recommendations

Major Recommendations

ACR Appropriateness Criteria®

Clinical Condition: Recurrent Symptoms Following Lower Extremity Angioplasty

Variant 1: Claudication.

Radiologic Procedure	Rating	Comments	RRL*
Segmental Doppler pressures and pulse volume recordings	9	Usual first tests.	O
MRA lower extremity without and with contrast	8	Able to triage between catheter and surgical management and thus may substitute for other noninvasive studies. See statement regarding contrast in text under "Anticipated Exceptions."	O
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative

Radiologic Procedure	Rating	Comments	RRL*
US lower extremity with Doppler	8	May be useful to identify focal lesions amenable to percutaneous intervention.	O
Arteriography lower extremity	7	Used for a lesion amenable to percutaneous intervention (e.g., restenosis).	
CTA lower extremity with contrast	7	Can be an alternative to MRA. Heavy calcification, especially in calf arteries, can limit evaluation of outflow disease.	
MRA lower extremity without contrast	6		O
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 2: Threatened limb.

Radiologic Procedure	Rating	Comments	RRL*
Arteriography lower extremity	9	Allows most timely diagnosis and treatment.	
Segmental Doppler pressures and pulse volume recordings	8		O
MRA lower extremity without and with contrast	5	Useful if angiography is not performed (i.e., surgical treatment is necessary). See statement regarding contrast in text under "Anticipated Exceptions."	O
CTA lower extremity with contrast	5	Useful if angiography is not performed, with limitations as described above.	
US lower extremity with Doppler	4	May be useful to identify focal lesions amenable to percutaneous intervention.	O
MRA lower extremity without contrast	4		O
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Summary of Literature Review

Introduction/Background

Endovascular therapy has supplanted bypass surgery as the primary invasive treatment modality for patients with peripheral arterial obstructive disease (PAOD). The Bypass versus Angioplasty in Severe Ischemia of the Limb (BASIL) trial showed that patients with critical limb ischemia (CLI) presenting with rest pain, ulceration, and gangrene of the leg due to infrainguinal disease had similar amputation-free survival and quality of life outcomes whether they were randomized to a surgery-first or an angioplasty-first treatment strategy. Furthermore, first-year costs associated with the bypass surgery were about one-third higher than with angioplasty. In the United States, endovascular therapy is now far more common than bypass surgery for the management of patients with severe claudication and CLI, and the number of surgical bypass procedures has fallen accordingly.

Restenosis after endovascular therapy is a pervasive issue, however. Restenosis is a manifestation of the reparative response to vessel injury and is characterized by late elastic recoil, smooth muscle cell proliferation, neointimal hyperplasia, and positive vessel wall remodeling. Stents have traditionally been used to bail out a failed angioplasty, as in cases of acute thrombosis, flow-limiting dissection, or significant residual stenosis >30%. Increasingly, however, stents are used as primary implants to inhibit positive vessel wall remodeling and prolong target lesion patency rates. However, stents also suffer from neointimal hyperplasia, so identifying those patients with restenosis requiring target lesion revascularization is of obvious interest. Nevertheless, relatively few studies have focused on the importance of patient follow-up after lower-extremity intervention. Recurrent symptoms of claudication usually precede the onset of limb- or life-threatening events in patients with lower extremity arterial disease, and it is the recurrence of these symptoms that typically drives patient assessment.

Clinical examination with periodic evaluation of the peripheral pulses and a determination of the resting and, if possible, postexercise ankle-brachial indices (ABIs) should be a standard part of the surveillance program after revascularization. However, restenosis is often undetected clinically, and the natural progression of PAOD frequently leads to the development of new lesions at different sites. Thus, radiographic imaging is essential for the accurate diagnosis and subsequent treatment of the recurrent stenoses that develop after initial endovascular therapy.

Noninvasive Hemodynamic Studies

Segmental limb pressures (SLP) and pulse volume recordings (PVR, also known as segmental plethysmography) are the most commonly performed noninvasive tests for evaluating peripheral arterial disease. Deterioration of SLP from previous levels by ≥15% has been accepted as indicative of restenosis. However, this measurement does not clearly specify the site or length of the lesion beyond general terms, such as "femoropopliteal" or "inflow" disease, and it is of little value in patients with noncompressible arteries, as often occurs in diabetics and patients with renal insufficiency. Similarly, segmental PVR, a useful adjunct in calcified arteries, is not accurate with regard to location or length of lesions, nor does it provide specific enough information for treatment decision-making in patients with symptomatic recurrent peripheral vascular disease. In conjunction with ABIs, however, it does provide a useful guide to the overall clinical severity of the obstructive disease.

Ultrasound (US) Imaging

Duplex US imaging is the least expensive cross-sectional imaging modality and has widespread usage and acceptance in this patient population, although some uncertainty exists regarding its utility and cost-effectiveness following endovascular therapy. Nevertheless, early duplex US after infrainguinal endovascular therapy for CLI has been shown to be predictive of primary lesion patency and subsequent limb loss and may even help identify residual stenotic lesions missed by conventional angiography. In patients with CLI, duplex US surveillance can be used to ensure high limb salvage rates after infrapopliteal angioplasty as well.

Duplex US is highly operator dependent, but in expert hands, there is a high, although not perfect, correlation with catheter angiography, especially for infrainguinal disease. While preoperative duplex US can be used to establish an appropriate revascularization strategy, the Diagnostic Imaging of Peripheral Arterial Disease (DIPAD) study showed that duplex US was less clinically useful than magnetic resonance angiography (MRA) or computed tomography angiography (CTA), and since more patients undergo additional vascular imaging after an initial duplex US, the total diagnostic costs per patient after an initial duplex US are higher than those after an initial CTA and similar to those after an initial MRA. As discussed below, when compared to duplex US, contrast-enhanced MRA (CE-MRA) is more sensitive and specific for PAOD.

Catheter Angiography

Digital subtraction angiography (DSA) is still considered the gold standard for imaging of PAOD. DSA can localize and quantify obstructive lesions with an accuracy exceeded only by intravascular US. Moreover, it permits physiological evaluation by determining pressure gradients. In addition to its diagnostic capabilities, DSA allows for intervention at the time of diagnosis, which can prove invaluable in patients with a threatened limb. In high-acuity settings, such as a thrombosed bypass graft, where immediate catheter-based intervention is likely to be indicated, direct referral to catheter angiography is the preferred option. However, DSA is an invasive technique with a small but definite risk in every patient and a variable higher risk in patients with severe widespread vascular disease, diabetes, renal insufficiency, or other contraindications to the use of iodinated contrast media. Carbon dioxide angiography may be of value in these patients. In light of the risk of nephrogenic systemic fibrosis (NSF) in patients with severe renal disease, gadolinium chelates serve a very limited role as DSA contrast agents.

Computed Tomography Angiography

Early multidetector computed tomography (MDCT) had insufficient spatial resolution, temporal resolution, and volume coverage per gantry rotation to adequately evaluate the lower extremity arterial system. With improvements in MDCT technology, CTA has become much more relevant in the imaging of peripheral vascular disease. CTA now has several advantages over DSA, including shorter examination times, lower complication rates, direct visualization of mural plaque and calcium, and 3-dimensional (3D) volumetric display and analysis. Although relatively noninvasive compared with catheter angiography, CTA has similar relative limitations related to radiation exposure and the use of iodinated contrast medium. Furthermore, if used as the initial imaging modality, CTA can significantly reduce diagnostic costs compared to DSA and MRA

in patients with PAOD.

Several studies have demonstrated the excellent diagnostic accuracy of CTA in evaluating aortoiliac and peripheral vascular disease. CTA findings can reliably lead to correct treatment recommendations in patients with intermittent claudication and with CLI. Although it is particularly useful for evaluating a defined vascular segment, CTA is still somewhat limited in its ability to grade the severity of stenotic lesions accurately when the volume of calcified plaque in a vessel is high with respect to the diameter of the vessel, which is an important limitation when using CTA to plan interventions in the foot and calf. Metal artifacts also limit the role of CTA in stent surveillance, although image interpretability and diagnostic accuracy continue to improve with advances in MDCT technology.

One potential advance in the noninvasive imaging of PAOD over conventional CTA is dual-energy (DE) CTA. DE-CTA can take advantage of element-specific attenuations to differentiate between calcium and iodine. Automated bone and plaque subtraction can therefore be applied with considerable time savings over conventional postprocessing techniques and more accurate generation of CTA-luminograms, although plaque subtraction is less reliable below the knee.

Magnetic Resonance Angiography

CE-MRA is a widely used modality for imaging of PAOD. It is noninvasive and low-risk and can image the entire vascular system, including tibial and pedal arteries. Recent work at 3 Tesla with parallel imaging and multichannel coils has shown nearly isotropic submillimeter voxels throughout the entire peripheral arterial tree. Time-resolved MRA may correlate more accurately with catheter angiography, especially in the calf vessels where minimizing venous contamination is essential. Moreover, in a patient with total occlusion, CE-MRA more reliably defines the reconstituted vessels. Metallic stents, especially stainless steel, cause signal intensity dropout, which can be indistinguishable from an occlusion. This is less of a problem with nitinol stents. CE-MRA is now widely available, and its use, especially in conjunction with duplex US, allows for reliable determination of appropriate intervention when symptoms occur after angioplasty.

There are several important limitations of MRA. Patients with defibrillators, spinal cord stimulators, intracerebral shunts, cochlear implants, and other devices are excluded, as are patients affected by claustrophobia that is not amenable to sedation. It takes longer to acquire images with MRA as compared to CTA, and the studies themselves are considerably more expensive. However, with MRA, patients are not exposed to ionizing radiation, and the nephrotoxicity of gadolinium-based contrast is generally considered less than that of iodinated contrast agents.

A serious concern with CE-MRA and the use of gadolinium-based contrast agents is the risk of NSF in patients with impaired renal function (see "Anticipated Exceptions" below). This has revitalized interest in noncontrast MRA for the imaging of PAOD. Advances in magnetic resonance (MR) technology along with the application of parallel imaging have reduced acquisition times sufficiently to render several new techniques clinically relevant. Recently developed electrocardiogram (ECG)-gated 3D partial Fourier fast spin-echo techniques (also known as "fresh blood imaging" or FBI) allow for shorter acquisition times than previous time-of-flight (TOF) or phase-contrast techniques. Further improvements, in particular for the depiction of pedal circulation, will be required. An important limitation of FBI is that it requires preparatory scans to determine acquisition windows, optimal trigger delays, and spoiler gradients, adding time to the study and potentially introducing operator variability. Compared to other noncontrast imaging methods, quiescent-interval single-shot (QISS), a balanced steady-state free-precession-based technique, may offer a more consistent signal over a wider range of flow velocities, which is relevant in the imaging of small arteries and vessel stenoses. The diagnostic performance of QISS MRA is nearly equivalent to that of CE-MRA and DSA. Further investigation of these techniques and others at 3 Tesla is required.

Summary

A complete vascular physical examination, including measurement of the ABIs, is always the first step in assessing a patient with recurrent symptoms after an initially successful endovascular intervention. With this information, appropriate imaging studies can be ordered. If it is clear that reintervention is necessary, as is often the case with a threatened limb, proceeding directly to catheter angiography is timely and appropriate. Preliminary duplex US imaging in less urgent cases may be helpful to define the problem by confirming a recurrence at the previously treated site or suggesting progression elsewhere.

Both MRA and CTA continue to develop and assume a greater role in patient evaluation. Some of the development is evolutionary, such as the use of time-resolved sequences in CE-MRA or the techniques of noncontrast MRA. Additional early work includes imaging the graft vessel wall in addition to the lumen to give further information towards understanding the biology of recurrent disease after intervention in patients with PAOD. In parallel with developments in imaging technology, new gadolinium-based MR contrast agents with improved properties for vascular imaging have been developed. The Food and Drug Administration (FDA) recently approved gadofosveset trisodium, a molecule that binds more strongly to serum albumin than other gadolinium agents, resulting in a better visualization of vascular system. Gadobenate dimeglumine also has advantages in vascular depiction in comparison to other conventional gadolinium-based agents.

Another fundamental development is CT scanners with two keV settings (DE CTA), in theory allowing separation between calcium and iodinated

contrast material. However, plaque subtraction is still challenging, particularly for infrapopliteal lesions.

At present there is only anecdotal experience with the new techniques and contrast agents discussed above, and thus while they are extremely promising, their use must ultimately be supported by scientific evidence. Current MRI and CT protocols are robust, but they are somewhat limited in practice by the meager distribution of high-end MRI and MDCT equipment and the limited number of professionals trained to use them. However, where this equipment and expertise are more available, the improved accuracy, comprehensiveness, and reproducibility of MRI and CT make them appropriate first examinations after clinical examination. The choice of modality is usually related to the expertise of the imager. MRA still has the advantage of more easily visualizing lesions obscured by overlying bone cortex in the calf, in particular the anterior tibial artery. In properly screened patients or in patients who are at risk for significant reactions to iodinated contrast agents, MRA is the procedure of choice.

- Clinical examination and measurement of the ABI is an essential first step in assessing patients with recurrent symptoms after prior lower-extremity revascularization.
- Catheter-based angiography is the gold standard in patients with a threatened limb, allowing for intervention at the time of diagnosis.
- Both MRA and CTA can be used to triage between endovascular and open surgical management.
- Newer noncontrast MRA techniques provide a reasonable alternative to CE-MRA in patients with renal insufficiency or other contraindication to the administration of gadolinium-based contrast agents.

Anticipated Exceptions

Patients presenting with critical recurrent ischemia with motor and sensory deficit occurring shortly after a percutaneous intervention (<7-10 days), and in whom the anatomy is well understood, should proceed directly to surgical revascularization by bypass or mechanical thrombectomy.

Nephrogenic systemic fibrosis (NSF) is a disorder with a scleroderma-like presentation and a spectrum of manifestations that can range from limited clinical sequelae to fatality. It appears to be related to both underlying severe renal dysfunction and the administration of gadolinium-based contrast agents. It has occurred primarily in patients on dialysis, rarely in patients with very limited glomerular filtration rate (GFR) (i.e., <30 mL/min/1.73 m^2), and almost never in other patients. There is growing literature regarding NSF. Although some controversy and lack of clarity remain, there is a consensus that it is advisable to avoid all gadolinium-based contrast agents in dialysis-dependent patients unless the possible benefits clearly outweigh the risk, and to limit the type and amount in patients with estimated GFR rates <30 mL/min/1.73 m^2. For more information, please see the American College of Radiology (ACR) Manual on Contrast Media (see the "Availability of Companion Documents" field).

Abbreviations

- CTA, computed tomography angiography
- MRA, magnetic resonance angiography
- US, ultrasound

Relative Radiation Level Designations

Relative Radiation Level*	Adult Effective Dose Estimate Range	Pediatric Effective Dose Estimate Range
O	0 mSv	0 mSv
☐	<0.1 mSv	<0.03 mSv
☐☐	0.1-1 mSv	0.03-0.3 mSv
☐☐☐	1-10 mSv	0.3-3 mSv
☐☐☐☐	10-30 mSv	3-10 mSv
☐☐☐☐☐	30-100 mSv	10-30 mSv
*RRL assignments for some of the examinations cannot be made, because the actual patient doses in these procedures vary as a function of a number of factors (e.g., region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as “Varies.”		

Clinical Algorithm(s)

Algorithms were not developed from criteria guidelines.

Scope

Disease/Condition(s)

Recurrent symptoms following lower extremity angioplasty for peripheral arterial obstructive disease (PAOD):

- Claudication
- Threatened limb

Guideline Category

Diagnosis

Clinical Specialty

Internal Medicine

Radiology

Surgery

Intended Users

Health Plans

Hospitals

Managed Care Organizations

Physicians

Utilization Management

Guideline Objective(s)

To evaluate the appropriateness of initial radiologic examinations for recurrent symptoms following lower extremity angioplasty

Target Population

Patients with recurrent symptoms following lower extremity angioplasty for peripheral arterial obstructive disease (PAOD)

Interventions and Practices Considered

1. Segmental Doppler pressures and pulse volume recordings
2. Magnetic resonance angiography (MRA) lower extremity
    - Without and with contrast
    - Without contrast
3. Ultrasound (US) lower extremity with Doppler
4. Arteriography lower extremity

5. Computed tomography angiography (CTA) lower extremity with contrast

Major Outcomes Considered

Utility of radiologic examinations in evaluation of recurrent symptoms following lower extremity angioplasty

Methodology

Methods Used to Collect/Select the Evidence

Searches of Electronic Databases

Description of Methods Used to Collect/Select the Evidence

Literature Search Procedure

The Medline literature search is based on keywords provided by the topic author. The two general classes of keywords are those related to the condition (e.g., ankle pain, fever) and those that describe the diagnostic or therapeutic intervention of interest (e.g., mammography, MRI).

The search terms and parameters are manipulated to produce the most relevant, current evidence to address the American College of Radiology Appropriateness Criteria (ACR AC) topic being reviewed or developed. Combining the clinical conditions and diagnostic modalities or therapeutic procedures narrows the search to be relevant to the topic. Exploding the term "diagnostic imaging" captures relevant results for diagnostic topics.

The following criteria/limits are used in the searches.

1. Articles that have abstracts available and are concerned with humans.
2. Restrict the search to the year prior to the last topic update or in some cases the author of the topic may specify which year range to use in the search. For new topics, the year range is restricted to the last 5 years unless the topic author provides other instructions.
3. May restrict the search to Adults only or Pediatrics only.
4. Articles consisting of only summaries or case reports are often excluded from final results.

The search strategy may be revised to improve the output as needed.

Number of Source Documents

The total number of source documents identified as the result of the literature search is not known.

Methods Used to Assess the Quality and Strength of the Evidence

Weighting According to a Rating Scheme (Scheme Given)

Rating Scheme for the Strength of the Evidence

Strength of Evidence Key

Category 1 - The conclusions of the study are valid and strongly supported by study design, analysis and results.

Category 2 - The conclusions of the study are likely valid, but study design does not permit certainty.

Category 3 - The conclusions of the study may be valid but the evidence supporting the conclusions is inconclusive or equivocal.

Category 4 - The conclusions of the study may not be valid because the evidence may not be reliable given the study design or analysis.

Methods Used to Analyze the Evidence

Review of Published Meta-Analyses

Systematic Review with Evidence Tables

Description of the Methods Used to Analyze the Evidence

The topic author drafts or revises the narrative text summarizing the evidence found in the literature. American College of Radiology (ACR) staff draft an evidence table based on the analysis of the selected literature. These tables rate the strength of the evidence for all articles included in the narrative text.

The expert panel reviews the narrative text, evidence table, and the supporting literature for each of the topic-variant combinations and assigns an appropriateness rating for each procedure listed in the table. Each individual panel member forms his/her own opinion based on his/her interpretation of the available evidence.

More information about the evidence table development process can be found in the ACR Appropriateness Criteria® Evidence Table Development document (see the "Availability of Companion Documents" field).

Methods Used to Formulate the Recommendations

Expert Consensus (Delphi)

Description of Methods Used to Formulate the Recommendations

Modified Delphi Technique

The appropriateness ratings for each of the procedures included in the Appropriateness Criteria topics are determined using a modified Delphi methodology. A series of surveys are conducted to elicit each panelist's expert interpretation of the evidence, based on the available data, regarding the appropriateness of an imaging or therapeutic procedure for a specific clinical scenario. American College of Radiology (ACR) staff distributes surveys to the panelists along with the evidence table and narrative. Each panelist interprets the available evidence and rates each procedure. The surveys are completed by panelists without consulting other panelists. The ratings are a scale between 1 and 9, which is further divided into three categories: 1, 2, or 3 is defined as "usually not appropriate"; 4, 5, or 6 is defined as "may be appropriate"; and 7, 8, or 9 is defined as "usually appropriate." Each panel member assigns one rating for each procedure per survey round. The surveys are collected and the results are tabulated, de-identified and redistributed after each round. A maximum of three rounds are conducted. The modified Delphi technique enables each panelist to express individual interpretations of the evidence and his or her expert opinion without excessive bias from fellow panelists in a simple, standardized and economical process.

Consensus among the panel members must be achieved to determine the final rating for each procedure. Consensus is defined as eighty percent (80%) agreement within a rating category. The final rating is determined by the median of all the ratings once consensus has been reached. Up to three rating rounds are conducted to achieve consensus.

If consensus is not reached, the panel is convened by conference call. The strengths and weaknesses of each imaging procedure that has not reached consensus are discussed and a final rating is proposed. If the panelists on the call agree, the rating is accepted as the panel's consensus. The document is circulated to all the panelists to make the final determination. If consensus cannot be reached on the call or when the document is circulated, "No consensus" appears in the rating column and the reasons for this decision are added to the comment sections.

Rating Scheme for the Strength of the Recommendations

Not applicable

Cost Analysis

- Some uncertainty exists regarding duplex ultrasound (US) utility and cost-effectiveness following endovascular therapy. Since more patients

undergo additional vascular imaging after an initial duplex US, the total diagnostic costs per patient after an initial duplex US are higher than those after an initial computed tomography angiography (CTA) and similar to those after an initial magnetic resonance angiogram (MRA).
- If CTA is used as the initial imaging modality, it can significantly reduce diagnostic costs compared to digital subtraction angiography (DSA) and MRA in patients with peripheral arterial obstructive disease (PAOD).

Method of Guideline Validation

Internal Peer Review

Description of Method of Guideline Validation

Criteria developed by the Expert Panels are reviewed by the American College of Radiology (ACR) Committee on Appropriateness Criteria.

Evidence Supporting the Recommendations

Type of Evidence Supporting the Recommendations

The recommendations are based on analysis of the current literature and expert panel consensus.

Benefits/Harms of Implementing the Guideline Recommendations

Potential Benefits

Selection of appropriate radiologic imaging procedures for evaluation of patients with recurrent symptoms following lower extremity angioplasty

Potential Harms

- Digital subtraction angiography (DSA) is an invasive technique with a small but definite risk in every patient and a variable higher risk in patients with severe widespread vascular disease, diabetes, renal insufficiency, or other contraindications to the use of iodinated contrast media.
- Although computed tomography angiography (CTA) is relatively noninvasive as compared with catheter angiography, it has similar relative limitations related to radiation exposure and the use of iodinated contrast medium.
- Duplex ultrasound (US) is highly operator dependent. Also, since more patients undergo additional vascular imaging after an initial duplex US, the total diagnostic costs per patient after an initial duplex US are higher than those after an initial CTA and similar to those after an initial magnetic resonance imaging (MRA).

Gadolinium-based Contrast Agents

Nephrogenic systemic fibrosis (NSF) is a disorder with a scleroderma-like presentation and a spectrum of manifestations that can range from limited clinical sequelae to fatality. It appears to be related to both underlying severe renal dysfunction and the administration of gadolinium-based contrast agents. It has occurred primarily in patients on dialysis, rarely in patients with very limited glomerular filtration rate (GFR) (i.e., <30 mL/min/1.73m^2), and almost never in other patients. Although some controversy and lack of clarity remain, there is a consensus that it is advisable to avoid all gadolinium-based contrast agents in dialysis-dependent patients unless the possible benefits clearly outweigh the risk, and to limit the type and amount in patients with estimated GFR rates <30 mL/min/1.73m^2. For more information, please see the American College of Radiology (ACR) Manual on Contrast Media (see the "Availability of Companion Documents" field).

Relative Radiation Level (RRL)

Potential adverse health effects associated with radiation exposure are an important factor to consider when selecting the appropriate imaging procedure. Because there is a wide range of radiation exposures associated with different diagnostic procedures, a RRL indication has been

included for each imaging examination. The RRLs are based on effective dose, which is a radiation dose quantity that is used to estimate population total radiation risk associated with an imaging procedure. Patients in the pediatric age group are at inherently higher risk from exposure, both because of organ sensitivity and longer life expectancy (relevant to the long latency that appears to accompany radiation exposure). For these reasons, the RRL dose estimate ranges for pediatric examinations are lower as compared to those specified for adults. Additional information regarding radiation dose assessment for imaging examinations can be found in the ACR Appropriateness Criteria® Radiation Dose Assessment Introduction document (see the "Availability of Companion Documents" field).

Contraindications

Contraindications

- Digital subtraction angiography has a variable higher risk in patients with severe widespread vascular disease, diabetes, renal insufficiency, and other contraindications to the use of iodinated contrast media.
- There are several important limitations of magnetic resonance imaging. Patients with defibrillators, spinal cord stimulators, intracerebral shunts, cochlear implants, and other devices are excluded, as are patients affected by claustrophobia that is not amenable to sedation.

Qualifying Statements

Qualifying Statements

The American College of Radiology (ACR) Committee on Appropriateness Criteria and its expert panels have developed criteria for determining appropriate imaging examinations for diagnosis and treatment of specified medical condition(s). These criteria are intended to guide radiologists, radiation oncologists, and referring physicians in making decisions regarding radiologic imaging and treatment. Generally, the complexity and severity of a patient's clinical condition should dictate the selection of appropriate imaging procedures or treatments. Only those examinations generally used for evaluation of the patient's condition are ranked. Other imaging studies necessary to evaluate other co-existent diseases or other medical consequences of this condition are not considered in this document. The availability of equipment or personnel may influence the selection of appropriate imaging procedures or treatments. Imaging techniques classified as investigational by the U.S. Food and Drug Administration (FDA) have not been considered in developing these criteria; however, study of new equipment and applications should be encouraged. The ultimate decision regarding the appropriateness of any specific radiologic examination or treatment must be made by the referring physician and radiologist in light of all the circumstances presented in an individual examination.

Implementation of the Guideline

Description of Implementation Strategy

An implementation strategy was not provided.

Institute of Medicine (IOM) National Healthcare Quality Report Categories

IOM Care Need

Getting Better

Living with Illness

IOM Domain

Effectiveness

Identifying Information and Availability

Bibliographic Source(s)

Schenker MP, Rybicki FJ, Dill KE, Desjardins B, Flamm SD, Francois CJ, Gerhard-Herman MD, Kalva SP, Mansour MA, Mohler ER III, Oliva IB, Weiss C, Expert Panel on Vascular Imaging. ACR Appropriateness CriteriaÂ® recurrent symptoms following lower extremity angioplasty. [online publication]. Reston (VA): American College of Radiology (ACR); 2012. 7 p. [70 references]

Adaptation

Not applicable: The guideline was not adapted from another source.

Date Released

1998 (revised 2012)

Guideline Developer(s)

American College of Radiology - Medical Specialty Society

Source(s) of Funding

The American College of Radiology (ACR) provided the funding and the resources for these ACR Appropriateness Criteria®.

Guideline Committee

Committee on Appropriateness Criteria, Expert Panel on Vascular Imaging

Composition of Group That Authored the Guideline

Panel Members: Matthew P. Schenker, MD (*Principal Author*); Frank J. Rybicki, MD, PhD (*Panel Chair*); Karin E. Dill, MD (*Panel Vice-Chair*); Benoit Desjardins, MD, PhD; Scott D. Flamm, MD; Christopher J. Francois, MD; Marie D. Gerhard-Herman, MD; Sanjeeva P. Kalva, MD; M. Ashraf Mansour, MD; Emile R. Mohler III, MD; Isabel B. Oliva, MD; Clifford Weiss, MD

Financial Disclosures/Conflicts of Interest

Not stated

Guideline Status

This is the current release of the guideline.

This guideline updates a previous version: Rybicki FJ, Kumamaru KK, Yucel EK, Baum RA, Desjardins B, Flamm SD, Foley WD, Jaff MR,

Koss SA, Mammen L, Mansour MA, Mohler ER III, Narra VR, Schenker MP, Expert Panel on Vascular Imaging. ACR Appropriateness Criteria® recurrent symptoms following lower extremity angioplasty. [online publication]. Reston (VA): American College of Radiology (ACR); 2009. 6 p.

Guideline Availability

Electronic copies: Available from the American College of Radiology (ACR) Web site .

Print copies: Available from the American College of Radiology, 1891 Preston White Drive, Reston, VA 20191. Telephone: (703) 648-8900.

Availability of Companion Documents

The following are available:

- ACR Appropriateness Criteria®. Overview. Reston (VA): American College of Radiology; 2 p. Electronic copies: Available in Portable Document Format (PDF) from the American College of Radiology (ACR) Web site .
- ACR Appropriateness Criteria®. Literature search process. Reston (VA): American College of Radiology; 1 p. Electronic copies: Available in PDF from the ACR Web site .
- ACR Appropriateness Criteria®. Evidence table development – diagnostic studies. Reston (VA): American College of Radiology; 2013 Nov. 3 p. Electronic copies: Available in PDF from the ACR Web site .
- ACR Appropriateness Criteria®. Radiation dose assessment introduction. Reston (VA): American College of Radiology; 3 p. Electronic copies: Available in PDF from the ACR Web site .
- ACR Appropriateness Criteria®. Manual on contrast media. Reston (VA): American College of Radiology; 90 p. Electronic copies: Available in PDF from the ACR Web site .
- ACR Appropriateness Criteria®. Procedure information. Reston (VA): American College of Radiology; 1 p. Electronic copies: Available in PDF from the ACR Web site .
- ACR Appropriateness Criteria® recurrent symptoms following lower extremity angioplasty. Evidence table. Reston (VA): American College of Radiology; 2012. 24 p. Electronic copies: Available from the ACR Web site .

Patient Resources

None available

NGC Status

This summary was completed by ECRI on February 20, 2001. The information was verified by the guideline developer on March 14, 2001. This summary was updated by ECRI on March 31, 2003. The updated information was verified by the guideline developer on April 21, 2003. This summary was updated by ECRI on March 20, 2006. This summary was updated by ECRI Institute on May 17, 2007 following the U.S. Food and Drug Administration (FDA) advisory on Gadolinium-based contrast agents. This summary was updated by ECRI Institute on June 20, 2007 following the U.S. Food and Drug Administration (FDA) advisory on gadolinium-based contrast agents. This summary was updated by ECRI Institute on August 4, 2009. This NGC summary was updated by ECRI Institute on February 23, 2011. This NGC summary was updated by ECRI Institute on November 14, 2012.

Copyright Statement

Disclaimer

NGC Disclaimer

The National Guideline Clearinghouseâ„¢ (NGC) does not develop, produce, approve, or endorse the guidelines represented on this site.

All guidelines summarized by NGC and hosted on our site are produced under the auspices of medical specialty societies, relevant professional associations, public or private organizations, other government agencies, health care organizations or plans, and similar entities.

Guidelines represented on the NGC Web site are submitted by guideline developers, and are screened solely to determine that they meet the NGC Inclusion Criteria which may be found at http://www.guideline.gov/about/inclusion-criteria.aspx.

NGC, AHRQ, and its contractor ECRI Institute make no warranties concerning the content or clinical efficacy or effectiveness of the clinical practice guidelines and related materials represented on this site. Moreover, the views and opinions of developers or authors of guidelines represented on this site do not necessarily state or reflect those of NGC, AHRQ, or its contractor ECRI Institute, and inclusion or hosting of guidelines in NGC may not be used for advertising or commercial endorsement purposes.

Readers with questions regarding guideline content are directed to contact the guideline developer.